# Nursery propagation of woody and herbaceous perennials for the Prairie Provinces

Agriculture Canada

Publication 1733 E



Canada

CONVERSION FACTORS

| Metric units | Approximate conversion factors | Results in: |
|---|---|---|
| LINEAR | | |
| millimetre (mm) | x 0.04 | inch |
| centimetre (cm) | x 0.39 | inch |
| metre (m) | x 3.28 | feet |
| kilometre (km) | x 0.62 | mile |
| AREA | | |
| square centimetre ($cm^2$) | x 0.15 | square inch |
| square metre ($m^2$) | x 1.2 | square yard |
| square kilometre ($km^2$) | x 0.39 | square mile |
| hectare (ha) | x 2.5 | acres |
| VOLUME | | |
| cubic centimetre ($cm^3$) | x 0.06 | cubic inch |
| cubic metre ($m^3$) | x 35.31 | cubic feet |
| | x 1.31 | cubic yard |
| CAPACITY | | |
| litre (L) | x 0.035 | cubic feet |
| hectolitre (hL) | x 22 | gallons |
| | x 2.5 | bushels |
| WEIGHT | | |
| gram (g) | x 0.04 | oz avdp |
| kilogram (kg) | x 2.2 | lb avdp |
| tonne (t) | x 1.1 | short ton |
| AGRICULTURAL | | |
| litres per hectare (L/ha) | x 0.089 | gallons per acre |
| | x 0.357 | quarts per acre |
| | x 0.71 | pints per acre |
| millilitres per hectare (mL/ha) | x 0.014 | fl. oz per acre |
| tonnes per hectare (t/ha) | x 0.45 | tons per acre |
| kilograms per hectare (kg/ha) | x 0.89 | lb per acre |
| grams per hectare (g/ha) | x 0.014 | oz avdp per acre |
| plants per hectare (plants/ha) | x 0.405 | plants per acre |

COVER Green ash and plum seedlings in nursery field production.

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# Nursery propagation of woody and herbaceous perennials for the Prairie Provinces

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## Preface

This publication outlines procedures for propagating nursery-grown trees, shrubs, ground covers, and herbaceous perennials on a commercial scale. A general section on procedures for propagation is followed by specific sections outlining technical details for each kind of plant. The publication should serve as a practical manual for nursery growers.

The sections on seed and vegetative propagation provide general information and answer many questions commonly asked about seeds, budding, grafting, cuttings, layering, stooling, and special structures. It is a brief description of the procedures of plant propagation and not an exhaustive coverage of the principles.

The sections on specific propagation methods make recommendations about seed collection, overcoming seed dormancy, compatibility of rootstocks, and preparation of cuttings. There are separate sections for woody plants and herbaceous perennials; within each section the contents are listed alphabetically by genus. The index lists common names, alphabetically.

The publication presents the findings of research undertaken at the Morden Research Station during the past 60 years. It replaces, in part, *Propagation studies in fruits and ornamentals at Morden Experimental Farm*, 1964, Contribution No. 49, from the Experimental Farm, Research Branch, Agriculture Canada, Morden, Man. The new publication provides new information and emphasizes commercially important procedures.

Only nursery crops suitable for the Prairie Provinces have been included. Because nursery growers from all regions of Canada produce for the prairie market, the publication is useful nationally.

Several books, bulletins, and trade journals on topics related to the propagation of nursery crops are available. A list of suggested references is given in the bibliography. Other publications on propagation can be obtained from Agriculture Canada or your agricultural representative.

The nursery-crops industry in Canada is expanding more rapidly than any other branch of horticulture. The high demand for nursery

crops is encouraging new growers who may be untrained in nursery-crops propagation to begin nursery production.

Contributions by H. J. M. Temmerman and H. Hiebert, and by former staff of the Morden Research Station are gratefully acknowledged. The authors also wish to thank the staff at the Provincial Tree Nursery, Oliver, Alta., and the Prairie Farm Rehabilitation Administration, Indian Head, Sask., for reviewing this publication and suggesting improvements.

## Seed propagation

Each seed produces an entirely new plant. Seedlings produced from seeds of the same seed lot differ from one another, just as people do. Most plant materials that have been improved ornamentally, particularly through interspecific hybridization, cannot be propagated from seed because seedling variation is too great. Improved nursery cultivars that were selected for disease resistance, double flowering habit, unusual leaf color or shape, quality of fruit, particular tree form, and other improved characteristics fall into this group.

About 45% of the nursery plants sold on the prairies are propagated as seedling material. Also, many seedlings are propagated and used as rootstocks for budding and grafting. When they are used in this way, all should be uniformly vigorous and healthy but they do not need perfect uniformity of ornamental characters.

### Collection

Seedling growers may collect their own seeds or may buy them commercially. A seed that is adapted to your growing area is essential, because some species grow over a vast continental area in which climatic conditions can vary dramatically. Green ash, for instance, is native from Florida to northern Saskatchewan; the southern sources for seeds produce seedlings that, on the prairies, winter-kill to the snow line, whereas seeds from northern, prairie sources are adapted to the climatic conditions of the Prairie Provinces. Seeds must therefore be collected from a location similar in climate and latitude to the one in which the plants will eventually be grown. Seeds from a nearby location will produce seedlings that are genetically adapted to the climatic conditions imposed on them; seeds from other geographical areas of similar latitude and climate may also produce adapted seedlings. Latitude is especially important in seed collection, because the onset of winter hardening is triggered, in part, by decreasing day length, which varies with the latitude. In general, a seedling should not be grown more than 500 km north of the location in which the seed was collected. Altitudinal differences can also cause problems, and therefore variations of more than 1000 m elevation are not recommended.

At present, there are no commercial seed companies that offer seed specifically adapted to the climatic conditions of the prairies, and therefore nurseries must collect most of their seed from native stands and accurately named nursery and research plantings. It is best to collect seeds from superior plants, because the general character traits of the mother plant are inherited by its seedlings, even though there are variations among seedlings from the same mother plant. Superior traits include growth rate, disease resistance, plant hardiness, and plant form.

Knowledge of seed collection is acquired with many years of experience. The date that seeds should be collected differs every year and with each species. Seed maturity is usually associated with a change of fruit color from the immature green stage. The approximate collection date for each species is given in the section dealing with propagation methods for woody nursery stock. Some seeds are dispersed from the tree or shrub as soon as they are ripe; some are eaten by birds. A tardy collector would miss these seeds. There are other seeds, such as American basswood, that must be collected at the proper maturity to facilitate germination; if these are collected too early or too late, germination will be restricted. There are, of course, other seeds that may be collected over several weeks or more. The observant collector will soon get to know just when each type should be collected.

Proper labeling of freshly collected seed is essential. An overconfident seed collector who depends on memory rather than on proper labeling will inevitably discover a costly mix-up when he is ready to sow the seed. A good waterproof label should show the name of the species and the source of the seed, because sources may vary in germination and subsequent seedling vigor. The label should also show the day, month, and year of collection. This information indicates when you should collect the seed the following season.

## Cleaning

Seeds are cleaned to extract them from the enclosing fruit structures, to remove debris and extraneous material, and to eliminate damaged and empty seeds. Cleaning results in sound seed with high viability, which is less heavy and bulky and can therefore be stored easily. In general, clean seed is more adaptable to mechanical sowing and to such treatments as stratification; it also often germinates more quickly than whole fruit.

Various methods of cleaning may be used, depending on the size of sample and the type of seed. The methods depend on whether the fruit is dry dehiscent, dry indehiscent, large-seeded fleshy, or small-seeded fleshy.

Conifer cones should be collected before seed dispersal and placed in a drying chamber to facilitate cone opening and seed dispersal.

Dry dehiscent fruit, such as caragana and lupine, are easy to clean. Spread the sample thinly on the floor or on a bench in a warm, well-ventilated room. Cover the sample with large sheets of paper to prevent

the dehiscing seeds from scattering. When the seeds dehisce they can be separated from the debris by shaking them through a mesh screen or by exposing them to blasts of air from an air separator.

Seeds of dry indehiscent fruits, such as basswood capsules and maple samaras, are extracted by dehulling and dewinging machines. Once the seeds are extracted, they may be separated from the debris in the same manner as dehiscent seeds.

Cleaning seeds of fleshy fruit involves macerating the fruit to a pulp and then separating the seeds from the pulp. Large-seeded fruits can be appropriately macerated in large pails or buckets, but the pulp of some species still clings to the seeds. If the macerated fruit is simply left to sit for a few days, fermentation will take place, thus releasing the pulp from the seeds. Fermentation produces heat, which must be dissipated by occasional stirring to prevent loss of seed viability. The pulp and fruit are placed in a slightly tilted container that is overflowing with water. As the contents of the container are agitated, the pulp and empty seeds float out of the container with the water, leaving sound seed. The flotation technique is adaptable to large or small batches of seed.

There are seed cleaners available that pulp the flesh and clean the seed in one operation. Similar to a large blender, the machine consists of a plate spinning at the bottom of a seed hopper. The adjustable flanged plate, which can be rotated at various speeds, is set to leave an opening slightly smaller than the size of the seed to be cleaned. The action of the fruit against the plate and adjacent fruit removes the flesh, which is washed out of the machine through the clearance around the plate by a stream of water, leaving clean seed in the hopper. This seed cleaner performs well except for species with very small seeds. The Dybvig machine is particularly suited to stone fruits but it can also serve to macerate fleshy fruit such as apples, following which flotation can be used to separate the pulp from the seed.

Small-seeded fleshy fruit can be cleaned with an electric blender. The uncleaned seed and water are put into the blender container and are macerated by the use of short, successive on-off cycles. The short macerating cycles help to minimize injury to the seeds, and the sharp blades can be wrapped with rubber or masking tape. When the fruit is macerated, the pulp and seeds can be easily separated by flotation.

## Storage

Seeds are complete living organisms, and as such they must be stored to preserve viability. Seeds of different species vary in the length of time they remain viable in storage. Oak and Ohio buckeye seeds do not usually remain viable for more than a year; others, like caragana, can be stored for more than 30 years without much loss of viability. The longest period of time that a seed can be stored is not known for most nursery items, nor are the best storage conditions. A good general rule is to obtain a fresh seed supply every year or as often as good seed crops are available. The

quality of stored seed is only as good as the initial quality of the seed at time of storage. The appropriate moisture content of stored seed varies for each type of seed, and where known, it is given in this publication in the section on specific propagation methods for woody plants.

The three most important physical factors in seed storage are temperature, relative humidity, and oxygen. Seeds are usually stored at room temperature (21°C), refrigerator temperature (5°C), or freezer temperature (–20°C). Dry seeds have low physiological activity and can therefore be stored successfully over a wide temperature range. For dry seeds, relative humidity must be kept low, either by dehumidifying the entire storage area or by storing seeds in sealed containers. The duration of storage can often be extended by reducing the oxygen content, which can easily be accomplished by storing the seed in sealed containers.

Seeds that require high moisture content cannot tolerate subfreezing temperatures but can be kept well at temperatures just above freezing. Deterioration increases quickly as the temperature is raised above 5°C, because the respiration rate is increased. Higher respiration of moist seed requires adequate oxygen, and hence the storage container must allow oxygen exchange. Polyethylene bags that are from 4 to 10 mils thick are suitable. However, bags with less than 4-mil thickness do not provide adequate moisture control, and those with more than 10-mil thickness do not allow enough air exchange.

## Pregermination treatments

Seeds of nursery species that do not germinate when they ripen, even when they are exposed to optimal environmental conditions of temperature, moisture, aeration, and light, are said to be dormant. Dormancy is most often associated with seeds that ripen in the fall; it is a protective mechanism that prevents newly germinated seedlings from being destroyed by the cold of winter. However, a protective mechanism in nature can be detrimental in the nursery. Dormancy may result from hard seed coats or internal restrictions, or combinations of the two. Various pregermination treatments are used to overcome different types of dormancy.

Scarification is the process of etching the seed coat to facilitate moisture uptake and gas exchange, two factors essential to seed germination. For acid scarification, place a batch of seeds into concentrated sulfuric acid (technical grade) so that the seeds are covered. The mixture turns black because of the oxidation of the seed coat. Stir the mixture occasionally to ensure uniform scarification and to avoid overheating. The process usually takes about 30 minutes but can vary considerably according to the kind of seed. After scarification is complete, remove the seeds from the acid and rinse them thoroughly with water. Several precautions are essential. Never leave the seeds in the acid longer than specified because this may result in damage to the embryo. Do not let

sulfuric acid touch your skin or your clothing. Never add water to concentrated acid because excessive heat and splattering will result.

Mechanical scarification is any process of mechanically altering the seed covering to make it permeable to water and gases. Rubbing the seeds between layers of sandpaper is one simple method that is useful for small amounts of seed. For large-scale operations, seeds may be combined with coarse sand or gravel of a different size than the seed and tumbled in drums lined with sandpaper or in cement mixers. The optimal time for scarification can be determined by removing and soaking a sample of seeds to observe swelling with the naked eye or, if you prefer, with a hand lens. The seed coats should be dull but not so deeply pitted or cracked to expose the inner parts of the seed.

Cool stratification at 5°C (refrigerator temperature) is necessary before the seeds of many species of woody trees and shrubs can germinate. It permits physiological changes within the embryo to occur in preparation for germination. Place the seeds in a medium that holds moisture, provides aeration, and contains no toxic substances. Many media can be used but the most common mixture consists of peat moss and sand in equal parts. The medium should be moist but not so wet that water can be squeezed out. Mix the seeds with 10–30 times their volume of the medium and put them into boxes or polyethylene bags at 5°C. Start stratification treatments at the proper time so that they can terminate at the expected date of sowing.

Warm stratification at 21°C (room temperature) is required for a few nursery plants; it usually precedes cool stratification. It promotes microbial degradation of hard seed coats in such species as cotoneaster and hawthorn and it promotes embryo development in such species as black ash, which has an immature embryo at the time of seed ripening. Seeds are prepared for warm stratification in the same way as they are for cool stratification. The only outward difference between the two processes is the temperature at which the seeds are stored.

## Sowing

Seedbed preparation is critical to the successful establishment of a uniform stand of seedlings (Fig. 1). The site should have a well-drained, medium-textured soil. To facilitate drainage, raise the bed by furrowing or, if needed, by adding a soil amendment such as sand or peat moss. When you have prepared the seedbed in texture and layout, take measures to control weeds. Weeds are always a major problem in seed propagation, and therefore presowing fumigation should be considered. Fumigation reduces the need for labor-intensive hand weeding after sowing. See your local weed-control guide for specific fumigation recommendations.

Successful establishment of seedlings is dependent upon the sowing operation. The depth of sowing is important and is determined by the size

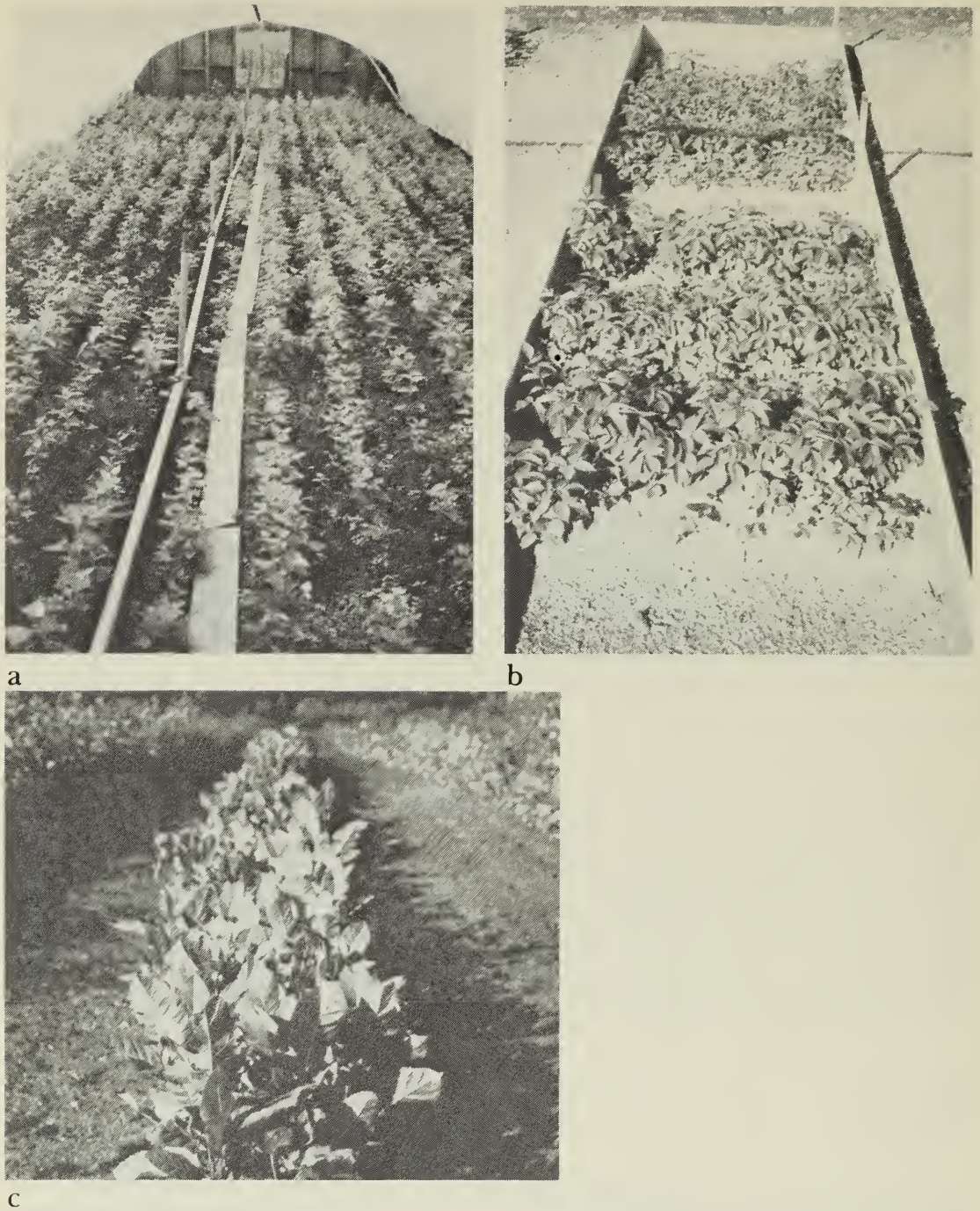

FIG. 1 Three methods for producing seedlings: (*a*) enclosed Quonset — ideal for seedlings such as birch, which are difficult to propagate outdoors; (*b*) seed frames — suitable for providing close control of conditions outdoors; (*c*) field rows — adequate for easily grown seedlings and adaptable to mechanized production.

of the seed and the time of year. Place large seeds deeper in the bed than small ones. If prompt germination is expected, sow the seed three or four times deeper than its diameter. Sow fall-sown seed, which is not expected to germinate until spring, slightly deeper than spring-sown seed. Pack the seedbed firmly and cover it with a thin layer of sand. The firm packing

ensures good seed contact with the moist soil; the layer of sand or other mulch prevents a hard crust from forming on the soil surface.

Fall- or summer-sown seed is exposed to the elements between the time of sowing and germination. The seed's greatest requirement is to be maintained uniformly moist throughout this period, and therefore irrigation may be necessary if there is low rainfall. A straw, sawdust, or sand mulch that is free of weed seeds helps to conserve moisture and prevents crusting of the soil surface, particularly with fall-sown crops. Fall-sown seeds need protection against predation by rodents. Rodent bait may be embedded into paraffin in Styrofoam cups and distributed throughout the seeded area.

## Vegetative propagation

Uniformity of plants is the objective of vegetative, or asexual, propagation. Although many new plants may be propagated from one stock plant, they are genetically identical to the original plant. Uniformity is possible because all clones have an identical genetic makeup. This characteristic distinguishes plants propagated vegetatively from those that are grown from seed. In vegetative propagation, roots, stems, buds, leaves, and modified storage structures are used to form new plants. There are many methods of vegetative propagation, including budding, grafting, various kinds of cuttings, layering, stooling, and dividing special structures. The type of propagation applicable to various ornamental plants is described in later sections.

### Budding and grafting

Budding and grafting are used to attach the bud (budding) or the scion (grafting) of a desirable cultivar to a rootstock. The bud (in budding) or the scion (in grafting) forms the aboveground part of the tree that is being propagated and retains exactly the same characteristics of the tree from which it was taken. The rootstock supplies the roots on which the bud or scion grows, and in the case of a seedling rootstock, the root may contribute a small measure of variability to the budded or grafted tree.

The budding or grafting operation is similar to an organ transplant. It requires care, cleanliness, proper timing, compatibility of scion and rootstock, and complete coverage of the wounded area by waxing or by tightly wrapping with rubber ties. The various techniques of budding and grafting are presented graphically in Agriculture Canada Publication 1289, *Fruit tree propagation*. The techniques for budding or grafting fruit trees are similar to those used for other nursery species.

Summer budding in late July and early August is the type most commonly used in North America. With T-budding, the growth of the

rootstock may be completed for the year, but the bark must slip freely from the wood. The bud is well developed and dormant at this time. The union between bud and stock occurs within 2 weeks but the bud should not begin growing until spring. To avoid fall budbreak and to ensure a "good catch," a schedule should be followed for all nursery species to be budded. The recommended sequence throughout the budding season is as follows: plum, pear, maple, hawthorn, ash, mountain ash, saskatoon, apple, basswood, birch, and poplar.

Chip budding may be used to extend the summer budding season. Chip budding, which does not require the bark to slip freely, has been used successfully for most items that are normally T-budded. Research at Morden, Man., showed that bud take and whip growth were similar for elm, apple, and basswood when budded by either method.

On occasion, a nursery grower may spring bud such plants as plums and ash, but this procedure has not worked as well for apples. Collect the budwood while it is still dormant and store it in polyethylene bags in the refrigerator. Spring bud plants during the first flush of growth. The bud union takes place within 10 to 12 days, the rootstock is cut back, and growth occurs during the summer to produce a salable plant (Fig. 2). Maturity is often delayed in the fall as a result of a late start in spring growth. Immature plants may be injured during the winter.

Whip and tongue grafting is used in propagation, but it is less common than budding. It is generally done indoors in late winter or early spring. Scion wood may be collected as required or may be gathered in advance and stored in polyethylene bags in the refrigerator. Approach, or side, grafting is used for winter grafting of conifers.

## Stem builders

Stem building has become a recommended orchard practice in northern apple-growing regions, where a hardy framework is required to withstand cold winters. The first step in building a hardy apple tree is to bud the stem-builder cultivar on a rootstock. This stem builder, which forms the trunk and main framework of the tree, is able to withstand severe winter weather without injury. Train the stem builder to a single trunk, with wide-angled branches spaced uniformly around the trunk to serve as a framework for the topworked cultivar. During the second or third years, bud the desirable fruit cultivar on the framework and grow it for another year in the nursery. Full details of the stem-building technique are given in Manitoba Department of Agriculture Publication 460, *Hardy stembuilders for prairie orchards.*

Stem-builder trees have several advantages over the straight rootstock-top cultivars. In addition to providing a hardy framework, the stem builder can induce hardiness and improved fruit color in the tender topworked cultivar. Strong, wide-angled branches can be used, resulting in less breakage and reduced maintenance. It is possible to bud several cultivars on one stem builder, thus creating a novel and yet very practical

FIG. 2 One-year budded whips of a black ash cultivar; seasonal growth is 2 m.

tree. Dwarf stem builders are more easily pruned, sprayed, and picked and are more suitable for small city lots. Dwarf stem-builder apple trees ('Columbia' rootstock, 'Nertchinsk' stem builder, and 'Goodland' top-worked) have proved productive for over 20 years at Morden, Man., and have matured at about two-thirds the tree size of the more vigorous 'Anaros' stem builder.

## Cuttings

Portions of stems, roots, or leaves from the stock plant can be induced to form the necessary parts of a new plant when they are placed under favorable environmental conditions. The use of cuttings is the most common method of propagating ornamental trees and shrubs. For species that can be propagated from this method, numerous plants can be

produced from a few stock plants in a limited space. There are several types of cuttings classified according to the plant part and its maturity (Fig. 3).

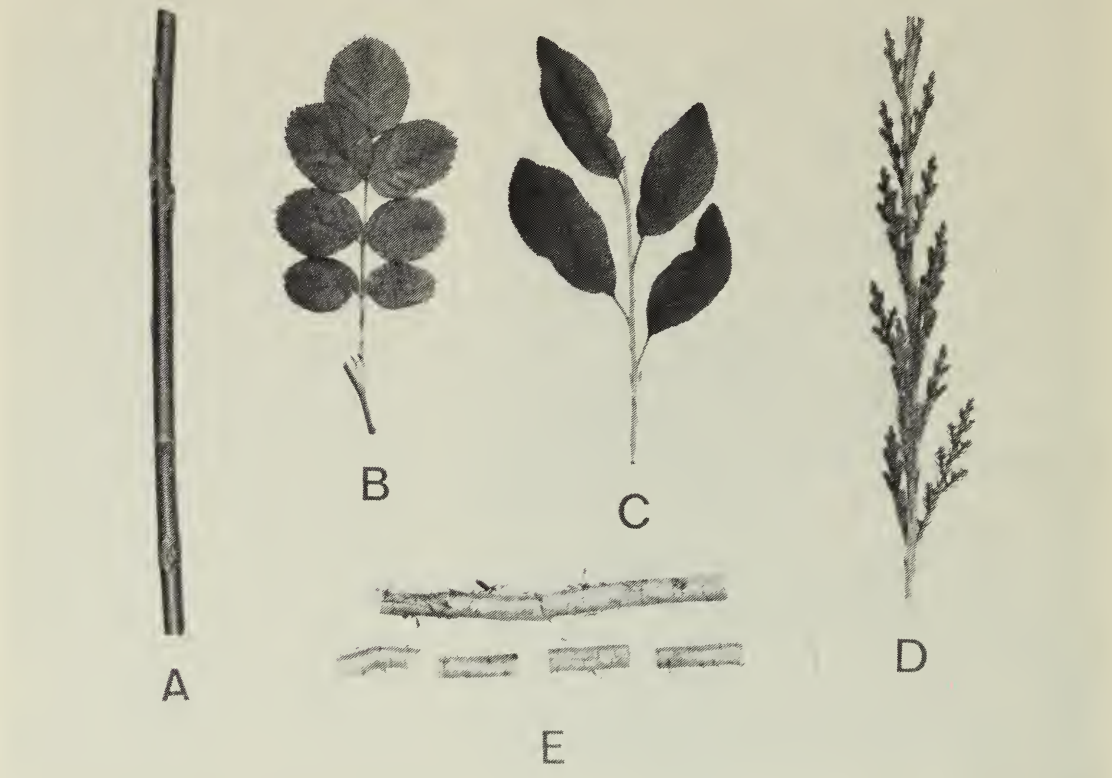


FIG. 3 Various kinds of cuttings including: (*a*) hardwood cutting of golden willow; (*b*) leaf-bud cutting of 'Morden Cardinette' rose; (*c*) softwood cutting of plum; (*d*) evergreen stem cutting of 'Prince of Wales' juniper; and (*e*) root cuttings of 'Tower' poplar.

## Deciduous hardwood stem cuttings

This is the easiest and least expensive method of vegetative propagation. Cuttings are prepared during the fall or early spring from the current season's growth. Mature stems are cut into pieces 15–20 cm long, each containing at least two nodes. Cuttings prepared in the fall are not exposed to the dehydrating winds of winter and do not suffer winter damage occasionally associated with cuttings collected in the spring. They should be stored at 1–5°C in polyethylene bags. Precondition the cuttings in moist peat at 10–15°C for 2 weeks before spring planting, to encourage root initiation. Cuttings planted directly into the field under irrigation will quickly produce rooted plants. As an alternative to spring planting, fall planting of hardwood cuttings has been used successfully by several prairie nurseries. Place cuttings at an angle in the soil with only the top bud above the soil, to ensure good contact between the cutting and the soil. Take care to place the cuttings with the buds upward; it is easy to get the wrong orientation of a cutting.

## Evergreen stem cuttings

Cuttings from coniferous trees are usually taken at the beginning of November and kept in a cool, moist place until mid-December, when they are propagated in the greenhouse. Remove the scales from the bottom 6 cm of the cutting. Dip the basal end into an 8000 ppm powdered formulation of indole-3-butyric acid (IBA), which is available as a prepared rooting hormone. Then place the cuttings into the propagation bed. The temperature in the greenhouse should be 16°C, whereas at the base of the cuttings in the propagation beds it should be kept at 21°C through the use of electrical heating cables. During the rooting process of 6 weeks to 3 months, only light, intermittent mist, or occasional surface watering is needed. Plant rooted evergreen cuttings into peat pots and maintain them in the greenhouse for lining into the nursery at the end of May.

If greenhouse facilities are not available, evergreen cuttings may be taken during May and June and placed in mist propagation units. When rooting has taken place in late August or early September, you should then transplant the cuttings directly into the nursery or into peat pots and store them over the winter in the cooler. You can greatly reduce losses of rooted evergreen cuttings by taking the extra precaution of potting them before transplanting them into the field. Winter propagation of evergreen cuttings is usually more successful than summer propagation.

## Softwood and leaf-bud cuttings

Prepare softwood cuttings early in the growing season from the new growing stems of woody or herbaceous plants. In the prairie region, softwood cuttings are usually taken in mid-June. The size of a cutting can vary from 5 cm to 20 cm, depending on the species and growing conditions. The cutting usually includes more than two nodes, and the foliage is removed from the lower portion of the cutting, which is then inserted into the rooting medium. Dip woody cuttings into 3000 ppm IBA and herbaceous cuttings into 1000 ppm IBA before you place them under mist.

Leaf-bud cuttings consist of a leaf, stem piece, and axillary bud. The stem piece creates new roots and the bud grows to form the shoot. Handle leaf-bud cuttings in the same manner as softwood cuttings. They are useful for a number of nursery items, such as Parkland roses and hydrangeas, in which vegetative growth is limited.

Place cuttings into a rooting medium, such as coarse sand and perlite or peat moss and perlite, that will provide good aeration and internal drainage. Succulent tissues may become diseased if there is excessive moisture, and wilting of the foliage will occur if moisture is inadequate. Keep the foliage turgid by intermittently applying a light mist. Install misting nozzles above the rooting bed and connect them to a timing device that controls the frequency and duration of each misting. Use the minimum amount of mist necessary to keep the foliage turgid. Gradually

decrease the amount of mist after roots begin to form, until it is eliminated. This prepares the cuttings for transplanting into small pots or for placing them directly into an intensive-care nursery.

Overwintering cuttings during the first winter sometimes presents a problem on the prairies, regardless of whether the cuttings have been transplanted to the field or stored indoors. The basic cause of poor overwintering is a lack of root development and vigor during the season of establishment. To ensure vigorous plant growth, fertilize the root zone with a weekly application of 20–20–20 fertilizer at 2000 ppm (2 g/L), starting as soon as root initials are formed and continuing throughout the growing season. Preparing the cuttings early in the summer, thereby allowing time for their establishment before winter, also helps the plants to overwinter successfully. Rooting the cuttings of some species directly into containers reduces the amount of transplant shock upon outplanting (Fig. 4).

### Root cuttings

Take root cuttings from well-developed roots during the dormant season. Prepare 2–8 cm cuttings from normal pruning that occurs before shipping. If you take cuttings in the fall, they may be stored in moist peat moss at 5°C. A warm pretreatment of up to 2 weeks in moist peat moss can be beneficial before planting root cuttings in the greenhouse or outdoors under irrigation. Etiolated softwood cutting sprouts from root cuttings can be used to propagate aspen poplars and saskatoons, which root poorly from conventional softwood cuttings.

## Layering

Layering is a form of vegetative propagation by which roots develop on a stem while they are still attached to the stock plants. When the rooted stem is detached it becomes a new plant and survives on its own roots. Layering can result in 30–40 new plants from each stock plant. Stock plants should be growing on their own roots. Cut back the plants close to the ground in early spring before the buds break.The strong branches that grow during the first summer will be ready for layering the following spring. Press firmly into loose soil 8–10 straight branches per plant, using U-shaped pieces of wire to pin the branches. Cover the branches lightly with soil. When the covered buds develop new shoots 6–8 cm high, place additional soil over the branch. Repeat the process several times until a total of 14–16 cm of the new shoots have been covered. Never put more soil around the base than half the height of the new shoots. The following spring carefully remove the soil from around the base, sever the newly rooted shoots from the stock plant, and transplant into nursery rows. Some pruning on the newly rooted plants is recommended. These plants should be of marketable size by fall.

FIG. 4 Softwood cuttings rooted in a book-type container and prepared for transplanting with root system intact.

## Crown divisions

The crown of a plant is the part from which new shoots develop. Numerous shoots are produced each year by herbaceous perennials and woody shrubs. The crown broadens with this type of growth, and every few years during the dormant season the crown can be divided into new plants. Each division contains a shoot, a piece of the crown, and some roots. Each division should be treated as a new plant and lined out in the field in spring. This method of propagation is simple and reliable; its limitation is that relatively few plants can be grown from each stock plant. Crown division has been used successfully to propagate saskatoon (*Amelanchier* cultivars) and perennials.

## Special structures

Special structures are modified plant parts, such as bulbs, corms, tubers, and tuberous roots, that contain food reserves. They are found on herbaceous perennials and are often the principal means of propagating them. The use of these structures is described in the section on propagation of perennials.

## Specific propagation methods for woody nursery stock

The approximate date for collecting seeds is given for each species.

| | | |
|---|---|---|
| *Abies* Fir | *A. balsamea* (L.) Mill. (balsam fir) | early September |
| | *A. lasiocarpa* (Hook.) Nutt. (alpine fir) | early September |
| | *A. sibirica* Ledeb. (Siberian fir) | early September |

Firs are usually grown from seed. Collect cones before they dehisce naturally and allow them to disintegrate by air-drying at 25–30°C for 3 weeks. Seed extracted from the cone has a wing attached, which should be removed with care so as not to damage the fragile seed. Seed may be stored in sealed containers for several years at 5°C. In nursery practice, the seed may be sown soon after extraction. If you store the seed, stratify it at 5°C for 2 or 3 months before sowing it. The dwarf *A. balsamea* 'Nana' (Nels.) Carr. is propagated by winter grafting.

| | | |
|---|---|---|
| *Acanthopanax* | *A. sessiliflorus* (Rupr. & Maxim. ex Maxim.) Seem. | late September |

Store cleaned seed at 5°C and sow it in early July. Germination can be expected the following spring. Experience with fall sowing at Morden is limited.

| | | |
|---|---|---|
| *Acer* Maple | *A. ginnala* Maxim. (Amur maple) | mid-September |
| | *A. negundo* L. (Manitoba maple, box-elder) | mid-September |
| | *A. rubrum* L. (red maple, swamp maple) | early June |
| | *A. saccharinum* L. (silver maple) | early June |
| | *A. saccharum* Marsh. (sugar maple, hard maple) | mid-September |

Maples are currently propagated in the prairies primarily from seed. The Morden 5507 seed strain of Amur maple is outstanding for its fall coloration. Grow hardy strains of red, silver, and sugar maples only from the northern-limit sources of these three native species. The moisture content at collection time of red and silver maple must be maintained throughout storage, whereas the storage requirements for the other species are not so exacting.

Maple seed is usually sown as soon as it is collected. Provide well-mulched seedbeds and some shade during seedling establishment. The fall-ripening seeds can be expected to germinate in the first spring. Freshly collected red and silver maple seeds generally germinate promptly following early summer planting.

Seedless selections of Manitoba maple have given more than 80% bud take on seedlings of this species. Hardy silver and red maple selections have been successfully budded on silver maple seedlings. In a single test, buds of silver maple, Tatarian maple, and Amur maple did not grow on rootstock of Manitoba maple.

Softwood cuttings of select Amur maple have been rooted by mist propagation, with moderate success.

*Aesculus* — *A. glabra* Willd. (Ohio buckeye) — late September

The best germination is obtained from fall sowing, although seeds may be stored moist in polyethylene bags at 1°C over the winter and sown in the spring. Moist stratification of stored seed for 1–3 months at 5°C may be necessary if the moisture content of the seed is low. Sow the seeds 5–7 cm deep in a well-drained seedbed and protect them from rodents.

*Amelanchier* — *A. alnifolia* Nutt. (saskatoon) — early July

Seedlings of improved cultivars are grown in nursery practice. Clean the seeds and store them in polyethylene bags for up to 1 or 2 years at 5°C. Fresh seed is usually sown in early August but it can also be sown later, in the fall. The Alberta Provincial Tree Nursery has achieved good results by sowing freshly collected macerated fruit. Mulch the seedbed and keep it moist until germination the following spring. Alternatively, seed may be stratified at 5°C for 3–4 months over the winter and sown in the spring. Some shade is beneficial during the first growing season.

Saskatoon cultivars, such as 'Honeywood,' 'Smoky,' 'Success,' and 'Thiessen,' must be propagated vegetatively. Cultivars that sucker can be propagated by removing the suckers during the dormant season and planting them in the field. Many new plants can be obtained from one large stock plant by dividing them in this way. Saskatoon cultivars are also propagated by budding on rootstocks of hedge cotoneaster. Budded plants should be planted deeply to avoid rootstock suckering and to develop plants with their own roots. Saskatoon cultivars have been successfully budded on American mountain ash, showy mountain ash, and

Greene's mountain ash at Morden, but growth has been only fair and rootstock suckering has been severe.

Root cuttings can be used to produce plants. In addition, etiolated softwood cuttings from these root cuttings can be rooted under mist. Summer propagation from softwood cuttings has given fair-to-moderate success with several selections at Morden.

| | | |
|---|---|---|
| *Amorpha* | *A. canescens* Pursh (leadplant) | early September |
| | *A. fruticosa* L. (common false indigo) | late August |

Seeds can be stored well for several years without requiring precise storage conditions. Impermeable seed coats when the seed is mature cause some restriction to germination, which can be overcome by fall sowing or by scarifying in concentrated sulfuric acid for 15–30 minutes.

| | | |
|---|---|---|
| *Arctostaphylos* | *A. uva-ursi* (L.) K. Spreng. (bearberry) | early August |

Bearberry is generally propagated by seed that can be stored well. For prompt germination, scarify the seed in concentrated sulfuric acid for 3–6 hours and then stratify it at 21°C for 2 months and at 5°C for an additional 2 months before sowing it in the spring.

| | | |
|---|---|---|
| *Betula* Birch | *B. occidentalis* Hook. (water birch) | September |
| | *B. papyrifera* Marsh. (paper birch, canoe birch) | September |
| | *B. pendula* Roth (European white birch) | September |

Viability of stored birch seed is highly dependent upon storage conditions. Store seed dry at 5°C in sealed containers for not longer than 2 years. Seed that is sown outdoors in June will germinate promptly under optimum conditions. Birch seed is small and needs light to germinate, and therefore it must be covered with only a thin layer of sand. Keep the seed both moist and exposed to the light during germination. The best results have been obtained by sowing it in flats or containers in the greenhouse in February and March, followed by transplanting the seedlings to frames in late May. Light shade improves seedling growth during the first 2 or 3 months.

'Tristis' and 'Youngii,' cultivars of European white birch, are budded on either paper birch or on seedlings of their own species, with sporadic results on the prairies. Budding as late as possible in the season results in the best bud take. Grafting during the dormant season can be successful.

| | | |
|---|---|---|
| *Caragana* | *C. arborescens* Lam. (caragana, Siberian peashrub) | mid-August |
| | *C. pygmaea* (L.) DC. (pygmy caragana) | late July |

Pick caragana seed before it disperses naturally, store it at 5°C, and sow it in late fall or in the spring. Seed sown at maturity will germinate but will not overwinter well.

*C. frutex* (L.) K. Koch 'Globosa' (globe caragana) may be propagated from softwood cuttings or crown divisions.

*C. arborescens* 'Lorbergii,' a fine-leaved form, and *C. arborescens* 'Sutherland,' a pyramidal form, may be propagated from hardwood or softwood cuttings. Softwood cuttings of caragana benefit from reduced mist; hardwood cuttings generally produce poor field stands and are therefore started in greenhouse beds.

The weeping cultivars of caragana, 'Pendula' and 'Walker,' are rooted from softwood cuttings or hardwood cuttings when they are intended to be grown as ground covers, or they are grafted to a standard to produce small weeping shrubs. *C. arborescens* 'Sutherland' is the recommended standard because there is little suckering.

| | | |
|---|---|---|
| *Celastrus* | *C. scandens* L. (bittersweet) | late September |

Seeds of bittersweet appear to have only a simple dormancy, which is overcome naturally by prompt fall sowing or by stratification at 5°C for 3 months, followed by spring sowing.

| | | |
|---|---|---|
| *Celtis* | *C. occidentalis* L. (common hackberry) | early October |

Hackberry fruit, which need not be cleaned, can be stored dry in sealed containers at 5°C for several years. Fall-sown hackberry seed germinates well in the first spring; spring-sown seed requires a 3-month cool stratification. The 'Delta' seed strain is an improved strain selected for hardiness.

Bud take of hackberry selections on hackberry rootstock has ranged sporadically from 10% to 50% in 3 years of testing.

| | | |
|---|---|---|
| *Clematis* | *C. macropetala* Ledeb. (big petal clematis) | late September |
| | *C. tangutica* (Maxim.) Korsh. (golden clematis) | early October |

Seed can be sown in the fall or stratified at 5°C for 3 months and sown in the spring. Clematis cultivars are propagated by softwood cuttings under mist.

| | | |
|---|---|---|
| *Cornus* Dogwood | *C. alba* L. (Tatarian dogwood) | late July |
| | *C. alternifolia* L. f. (pagoda dogwood) | mid-August |
| | *C. racemosa* Lam. (gray dogwood) | mid-August |
| | *C. sericea* L. (red-osier dogwood) | July–September |

Clean, air-dried seeds can be stored for up to 4 years in sealed containers at 5°C without loss of viability.

Tatarian, gray, and pagoda dogwood often germinate the following spring when freshly collected and cleaned seeds are sown as soon as they are collected but no later than 1 September. Stored seed that is sown in early July germinates the following spring; seed that is stratified at 21°C for 4 months, and then at 5°C for 3 to 4 months, germinates promptly following spring sowing. Red-osier dogwood seed is different: seed that is sown from September to late October or is stratified at 5°C for 3 months and sown in the spring will produce good stands.

Several cultivars of Tatarian, red-osier, and Siberian dogwood are commonly grown. They are propagated either as hardwood or softwood cuttings under mist during winter or summer, respectively.

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|---|---|---|
| *Corylus* | *C. americana* Marsh. (American hazel) | September |

Sow seeds soon after they are collected and protect them from rodents. It is possible to store husked seed in sealed containers for at least a year.

| | | |
|---|---|---|
| *Cotoneaster* | *C. integerrimus* Medic. (European cotoneaster) | September |
| | *C. lucida* Schlechtend. (hedge cotoneaster) | September |
| | *C. melanocarpus* Lodd. var. *laxiflorus* (Jacq. ex Lindl.) C.K. Schneid. (black-fruited cotoneaster) | September |
| | *C. submultiflora* Popov. (red bead cotoneaster) | late August |

Cotoneaster seed is surrounded by a hard endocarp and contains a dormant embryo. Germination is often poor. Collecting the fruit at an early stage of ripening in late August and sowing it promptly produces good germination the following spring. A second method is to store the seed until early July, sow it, and wait for germination the following spring. You can also pretreat the seed with concentrated sulfuric acid for 30

minutes to aid the softening of the endocarp. Following acid scarification, stratify the seed at 21°C for 2–3 months and then at 5°C for 3 months, in preparation for spring sowing. In one test, seed that was stratified for 3 months at 21°C, followed by 4 months at 5°C, germinated promptly after spring sowing. Sow seed 3 or 4 mm deep, to produce the best germination.

| | | |
|---|---|---|
| *Crataegus* Hawthorn | *C. arnoldiana* Sarg. (Arnold hawthorn) | late September |
| | *C. chlorosarca* Maxim. (blackfruit hawthorn) | late September |
| | *C. mollis* (Torr. & A. Gray) Scheele (downy hawthorn) | late September |
| | *C. rivularis* Nutt. (river hawthorn) | late September |

Cleaned, dried seed can be stored well at 5°C for 2–3 years. The percentage of nutlets containing sound seed may be low, because empty seeds do not float with the pulp during extraction. Germination of hawthorn seed is often poor because of a hard endocarp and a dormant embryo. In one study at Morden, seeds of Arnold hawthorn and blackfruit hawthorn were treated with sulfuric acid for 30 minutes and were sown immediately on 10 September. Thirty percent germination was recorded the following spring. The usual nursery practice is to store the seed until July, sow it, and wait for germination the following spring. Hawthorn seedlings soon develop a long taproot and they should not be kept in the seedbeds for more than a year.

Arnold hawthorn is widely compatible with other hawthorns and is recommended as the rootstock for named cultivars such as *Crataegus* ×*mordenensis* Boom 'Snowbird' and 'Toba.' Other rootstocks, including blackfruit hawthorn, downy hawthorn, and river hawthorn, have been evaluated and found to be less satisfactory because of either incompatibility or poor root development.

| | | |
|---|---|---|
| *Cytisus* Broom | *C. austriacus* L. (Austrian broom) | August |
| | *C. decumbens* (Durande) Spach (prostrate broom) | August |
| | *C. nigricans* L. (spike broom) | August |
| | *C. purpureus* Scop. (purple broom) | August |

Brooms are propagated either as hardwood or softwood cuttings under mist during the winter or summer, respectively.

| | | |
|---|---|---|
| *Daphne* | *D. cneorum* L. (garland daphne, rose daphne) | late August |

For seed propagation, store seed in a sealed container until it is sown in early October or until it is stratified at 5°C for 4 months and sown in the spring. Daphne is usually propagated from softwood cuttings under mist.

| | | |
|---|---|---|
| *Elaeagnus* | *E. angustifolia* L. (Russian olive) | early October |
| | *E. commutata* Bernh. (silverberry) | late September |

Sow seed soon after it is collected. In one test, seed that was sown as late as November 5 germinated 78% the following spring. Alternatively, seed can be stratified at 5°C for 2–3 months and sown in the spring.

| | | |
|---|---|---|
| *Euonymus* | *E. alatus* (Thunb.) Siebold (winged euonymus) | late September |
| | *E. maackii* Rupr. (Maack euonymus) | mid-September |

For best results, seeds should have their arils removed and should be sown in the fall, before the seed has dried. Alternatively, seeds may be stored moist over the winter with their arils removed, stratified at 5°C for 3 months, and sown in the spring. Germination is often poor.

*E. nanus* Bieb. 'Turkestanicus' (Turkestan euonymus) is propagated by softwood cuttings under mist.

| | | |
|---|---|---|
| *Fraxinus* Ash | *F. mandshurica* Rupr. (Manchurian ash) | late September |
| | *F. nigra* Marsh. (black ash) | late September |
| | *F. pennsylvanica* Marsh. (green ash, red ash) | late September |

Ash seed can be stored in polyethylene bags at 5°C for several years without appreciable loss of viability.

Green ash seed is usually sown soon after it is collected or it can be stratified at 5°C for 3 months and sown in the spring.

Seeds of black ash and Manchurian ash have embryos that are both immature and dormant, and that require warm stratification until the embryos elongate to the full length of the seed (about 3–4 months), followed by cool stratification for 4 months. Pregermination treatments are given over the winter before spring sowing. Alternatively, seed that is stored and sown in July will germinate the following spring. In one test with black ash at Morden, seed that was collected at the mature green stage during the first week of September and sown immediately germinated the following spring.

Selections and cultivars of the three recommended species are successfully propagated on the rootstock of green ash. The percentage of

bud take varies from year to year, and stands of 80–95% are common. Black ash can serve as a second choice for rootstock, at least for cultivars of its own species.

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|---|---|---|
| *Genista* Woodwaxen | *G. sagittalis* L. (sword leaf woodwaxen) | September |
| | *G. tinctoria* L. (dyer's greenweed, common woodwaxen) | late August |

Woodwaxens can be grown either from seed or softwood cuttings. There are no dormancy problems. Spring sowing usually results in prompt germination.

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|---|---|---|
| *Halimodendron* | *H. halodendron* (Pall.) Voss (salttree) | late September |

Seed should be sown soon after it is collected, because it is reported to deteriorate quickly in storage.

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|---|---|---|
| *Hippophae* | *H. rhamnoides* L. (common sea-buckthorn) | early September |

Seeds of sea-buckthorn can be sown in the fall or stored, stratified at 5°C for 3 months, and sown in the spring.

| | | |
|---|---|---|
| *Juglans* Walnut | *J. cinerea* L. (butternut) | late September |
| | *J. mandshurica* Maxim. (Manchurian walnut) | late September |
| | *J. nigra* L. (black walnut) | early October |

Seeds can be stored in polyethylene bags at 5°C for a year or more. Fall sowing or stratification at 5°C for 3 months, followed by spring sowing, is recommended. Protect against rodents, especially when you are sowing in the fall.

| | | |
|---|---|---|
| *Juniperus* Juniper | *J. chinensis* L. (Chinese juniper) | September |
| | *J. communis* L. (common juniper) | early September |
| | *J. horizontalis* Moench (creeping juniper) | September |
| | *J. sabina* L. (savin juniper) | September |
| | *J. scopulorum* Sarg. (Rocky Mountain juniper) | early October |

Juniper seed can be stored well for many years. Its hard seed coat and dormant embryo result in a double delay to germination. The seed

requires stratification at 21°C for 3½ months, followed by stratification at 5°C for 3½ months. After stratification, sow the seed in the spring. It is important to note, however, that junipers used for ornamental horticulture are rarely grown from seed.

Cultivars are propagated during the winter either by evergreen cuttings or grafting. Cultivars of the following species root from cuttings with decreasing ease: creeping juniper, Chinese juniper, savin juniper, common juniper, and Rocky Mountain juniper. Rocky Mountain juniper cultivars that root poorly, such as 'Medora' and 'Grizzly Bear', are usually propagated by winter grafting on Hetz rootstock.

| | | |
|---|---|---|
| *Larix* Larch | *L. laricina* (Du Roi) K. Koch (tamarack, American larch) | early September |
| | *L. sibirica* Ledeb. (Siberian larch) | early to mid-September |

Larch seed can be stored well for several years at 6–8% moisture content in sealed containers. No pregermination treatments are required. Seed can be sown in the spring or fall.

| | | |
|---|---|---|
| *Lonicera* Honeysuckle | *L. caerulea* L. *edulis* Regel (sweetberry honeysuckle) | late June |
| | *L. maackii* (Rupr.) Maxim. (Amur honeysuckle) | late September |
| | *L. maximowiczii* (Rupr.) Maxim. var. *sachalinensis* Friedr. Schmidt (Sakhalin honeysuckle) | late August |
| | *L. tatarica* L. (Tatarian honeysuckle) | late July |

Honeysuckle seed tends to lose viability rather quickly, unless it is stored at 5°C in sealed containers. Cleaned seed or whole berries are best sown after collection. Alternatively, the seed may be stratified at 5°C for 3½ months and sown in the spring.

Cultivars of the above species, *L. xylosteum* L. 'Nana' (dwarf fly honeysuckle), and *L. spinosa* Jacquem. ex Walp. var. *alberti* (Regel) Rehd. (Albert thorn honeysuckle) are propagated by softwood cuttings. The more vigorous honeysuckles, such as the Tatarian and Amur types, can be propagated from hardwood cuttings during the spring under irrigated-field conditions.

| | | |
|---|---|---|
| *Malus* Apple | *M.* 'Columbia,' 'Bedford,' and 'Dolgo' | late September |

Prairie apple rootstocks are grown from seed of *M.* 'Columbia,' 'Bedford,' and 'Dolgo'. The fruit is ready to pick when the seed coat turns brown. Seed is best sown soon after it is collected. Alternatively, if seed is stored over the winter, it should be stratified for 2 months before spring

sowing. Cleaned apple seed can be stored in sealed containers at 5°C for 2 years or more.

Cultivars of rosybloom flowering crab apples, crab apples, apple crabs, and apples are budded with excellent results on seedling rootstocks. Hardy dwarfing clonal rootstocks are not available for the prairie region. Hardy stem-builder cultivars, such as *M.* 'Nertchinsk' (dwarfing) and 'Kerr' (semidwarfing), are recommended for improving the adaptability of apples to cold regions (see section entitled "Stem builders").

*Ostrya* — *O. virginiana* (Mill.) K. Koch (ironwood, American hop hornbeam) — early September

The seed is ready to collect when the strobiles are pale greenish brown. Seed should be stratified at 21°C for 2 months and at 5°C for 4 months, followed by sowing in early spring. Alternatively, seed that is stored until it is sown in July will germinate the following spring.

An improved selection of ironwood yielded a 50% stand of whips when T-budded on ironwood seedlings in a 1-year test at Morden.

*Parthenocissus* — *P. quinquefolia* (L.) Planch. (Virginia creeper) — late September

Virginia creeper seed must be removed from the berries with care so as not to damage the soft seed. Cleaned seed can be sown soon after it is collected or it can be stored in polyethylene bags at 5°C, stratified at 5°C for 2 months, and then sown in the spring.

*Paxistima*

*P. canbyi* A. Gray (Canby pachystima) is usually propagated by fall divisions or by summer softwood cuttings.

*Phellodendron* — *P. amurense* Rupr. (Amur cork tree) — late September

Seeds of the Amur cork tree should be sown in the fall or stratified at 5°C for 3 months and sown in the spring.

An improved selection of Amur cork tree gave a 40% stand of whips from T-budding on seedlings of its own species in a 1-year test at Morden.

*Philadelphus* — *P. lewisii* Pursh (Lewis mock orange) — mid-September

Mock orange seed is very small and should be germinated in flats in the greenhouse. It requires no pregermination treatments but it does require light during germination. Mock orange is not propagated commercially by seed.

Cultivars such as *P.* 'Audrey' and 'Galahad' and *P. lewisii* Pursh 'Waterton' are usually propagated by softwood cuttings under mist. With

frequent, light irrigation, mock orange can be propagated from hardwood cuttings in the field, or hardwood cuttings can be rooted during the winter and lined out in the field in spring.

| | | |
|---|---|---|
| *Physocarpus* | *P. opulifolius* (L.) Maxim. (common ninebark) | late September |

Ninebark seeds require stratification at 5°C and spring sowing, according to a report from the Alberta Provincial Tree Nursery.

The cultivars *P. opulifolius* (L.) Maxim. 'Luteus' (goldleaf ninebark) and compact 'Darts Gold' are propagated from softwood or hardwood cuttings under mist.

| | | |
|---|---|---|
| *Picea* Spruce | *P. abies* (L.) Karst. (Norway spruce) | September |
| | *P. glauca* (Moench) Voss (white spruce) | September |
| | *P. pungens* Engelm. (Colorado spruce) | mid-September |

Collect spruce cones at maturity to avoid natural seed dispersal. Seed may be shaken or tumbled from the cone following a short period of air-drying. Once extracted, seed can be stored in sealed containers at 5°C for 5 years or longer without loss of viability.

Seed should be spring sown into a firm seedbed at a depth of 6–8 mm. The seeds require some light during germination, which necessitates sowing at the required depth. Some shade and good fertility during the first year and undercutting at the end of the first year will facilitate good seedling development.

Grafting is used to propagate the blue clones, such as *P. pungens* 'Koster,' 'Hoopsii,' 'Moerheimii,' and 'Morden,' and the dwarf clones, such as *P. pungens* 'Globosa' and 'Montgomery' and *P. abies* 'Nidiformis.' The last cultivar is also grown from cuttings.

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|---|---|---|
| *Pinus* Pine | *P. cembra* L. (Swiss stone pine) | early September |
| | *P. mugo* Turra (mountain pine, Mugo pine) | late September |
| | *P. ponderosa* Laws. (ponderosa pine) | late September |
| | *P. resinosa* Ait. (red pine) | late September |
| | *P. sylvestris* L. (Scots pine) | late September |

Collect pine cones at maturity; seed can be extracted after a period of air-drying. Freshly extracted seed can be stored in sealed containers at 5°C for many years. Seed dormancy of Swiss stone pine can be overcome

by stratification at 21°C for 1 month and then at 5°C for 3 months. Recently collected seed of the other species germinates without pretreatment when it is sown in the fall or spring. Seed that is stored for more than a year benefits from 1–2 months of stratification at 5°C .

*Populus* All species May–June
Poplar

Native aspens can be propagated from seed. Collect catkins just before dehiscence and air-dry them to facilitate seed extraction. Seed is best sown soon after collection, although it may be dried to 5–8% moisture and stored in sealed containers at –20°C for a year or longer. Poplar seed is small and should be sown shallowly in flats in the greenhouse. Seedlings are extremely susceptible to desiccation and to damping-off.

Hardwood cuttings are used for propagation of most poplars, except aspens and European white poplars. Either fall or spring planting is reliable for *P. jackii* Sarg. 'Northwest' (Northwest poplar), *P. deltoides* Bartr. ex Marsh. (cottonwood), and *P.* 'Brooks No. 6' (Brooks No. 6 poplar).

*P.* ×*canescens* (Ait.) Sm. 'Tower' (Tower poplar) is readily propagated from pencil-thick root cuttings that are 2 cm long. Root cuttings should be pretreated in moist peat moss in polyethylene bags for 2 weeks at 20°C before potting. Under mist, softwood cuttings also root readily but hardwood cuttings root only moderately well.

*P. tremula* L. 'Erecta' (Swedish columnar aspen) is difficult to root from softwood or hardwood cuttings but can be propagated by budding or grafting. Brooks No. 6 poplar is the recommended rootstock; *P. tremuloides* Michx. (aspen poplar, trembling aspen) is compatible but it may sucker. Scions of Swedish columnar aspen have been grafted directly to unrooted hardwood cuttings of Brooks No. 6 poplar and lined out in the field to permit simultaneous rooting of understock and callusing of scions. Alternatively, etiolated softwood cuttings from root cuttings will root under mist. The use of root cuttings as outlined above for 'Tower' poplar has been moderately successful.

*Potentilla*

Softwood cuttings of all cultivars of *P. fruticosa* L. root readily under mist. Hardwood cuttings under mist have been used for winter propagation.

*Prinsepia* *P. sinensis* (D. Oliver) D. Oliver ex Bean (cherry prinsepia) late August

Prinsepia seed responds to a rather unusual stratification treatment of 2 months at 5°C followed by 2½ months at 21°C. Seed that is stratified in this way and sown in the spring germinates soon after sowing. Fall-sown seed generally germinates in August of the following year.

| | | |
|---|---|---|
| *Prunus* | *P. americana* Marsh. (American plum) | August–early September |
| | *P. armeniaca* L. var. *mandshurica* Maxim. (Manchurian apricot) | late July–early August |
| | *P. besseyi* L. H. Bailey (western sand cherry) | August |
| | *P.* ×*dropmoreana* | late July–early August |
| | *P. fruticosa* Pall. (Mongolian cherry, European ground cherry) | late July–early August |
| | *P. nigra* Ait. (Canada plum) | August–early September |
| | *P. padus* L. (May Day tree, European bird cherry) | late July |
| | *P. pensylvanica* L. f. (pin cherry, wild red cherry) | late July–early August |
| | *P. serotina* J.F. Ehrh. (black cherry) | late August–early September |
| | *P. tenella* Batsch (dwarf Russian almond) | late August |
| | *P. triloba* Lindl. (flowering almond) | late August |
| | *P. tomentosa* Thunb. (Nanking cherry) | late July–early August |
| | *P. virginiana* L. (red chokecherry, chokecherry) | late August–early September |

Excessive drying of *Prunus* seed after removing the fruit may be detrimental to seed viability. Seed that is to be sown shortly after collection need not be dried at all. For storage, seed should be dry on the surface. Fall sowing, preferably before October, is recommended for all *Prunus* seed. Seed that matures early in the season can be collected, cleaned, and stored in polyethylene bags at 5°C until the desired sowing date. As an alternative to fall sowing, stratify the seed at 5°C for 4 months and sow it in the spring.

'Shubert' chokecherry (*P. virginiana* 'Shubert') and 'Dropmore' mayday (*P. padus* 'Dropmore') should be propagated on a uniform nonsuckering strain of *P. padus*, such as seedlings of the 'Dropmore' cultivar. Evaluation of Amur chokecherry and *P.* ×*dropmoreana* indicates only a poor to fair compatibility with *P. padus* 'Dropmore.'

The pin cherry cultivars 'Stockton' and 'Jumping Pound' have been propagated successfully on seedlings of either pin cherry or Amur chokecherry.

*P. triloba* 'Multiplex' and its hybrids with flowering almond (*P. pedunculata* (Pall.) Maxim.) are best budded on Nanking cherry.

Muckle plum (*P. nigrella* Cumming 'Muckle' ) should be budded on seedling plum rootstock.

To propagate good-quality fruit plums, seedlings of hardy plums ('Norther,' 'Bounty') are the first choice and seedlings of Nanking cherry are the second.

| | | |
|---|---|---|
| *Pyrus* Pear | *P. ussuriensis* Maxim. (Ussurian pear) | late September |

Handle pear seed as you do apple seed. Sow seeds in late September. Good germination in the spring may be expected. If seed is stored over the winter, it requires stratification at 5°C for 3 months before sowing in the spring.

Seedlings of Ussurian pear are the first choice as rootstocks for fruit cultivars. Seedlings of hardy cultivars, such as 'Tait Dropmore' and 'Pioneer No. 3', are often used as rootstocks as well.

| | | |
|---|---|---|
| *Quercus* Oak | *Q. macrocarpa* Michx. (bur oak) | early September |
| | *Q. mongolica* Fisch. ex Turcz. Mongolian oak) | early September |

Oak seed is usually sown in the fall soon after it is collected. Seedbeds should be mulched with leaves or straw held in place by a wire screen that protects them from rodents. Seed can be stored in polyethylene bags at 1°C for a year. If the seed is stored at 5°C, sprouting begins within 3 or 4 months; if it is stored at –2°C, some loss of viability occurs. Maintain the moisture content of the seed at collection time throughout storage.

| | | |
|---|---|---|
| *Rhus* Sumac | *R. glabra* L. (smooth sumac) | late September |

Sumac seed can be stored in sealed containers at 5°C for 3 years or longer and is usually sown in the fall. Because the seed has a hard seed coat, which hinders germination, soaking it in boiling water for 2 or 3 minutes or scarifying it with sulfuric acid for 1 hour may prove beneficial, although these treatments have not been verified.

| | | |
|---|---|---|
| *Ribes* Currant | *R. alpinum* L. (alpine currant) | late July |
| | *R. aureum* Pursh (golden currant) | early July |
| | *R. diacanthum* Pall. (Siberian currant) | late July |
| | *R. odoratum* H. Wendl. (Buffalo currant, Missouri) | late July |

Seed viability can be maintained for several years in sealed containers at 5°C. Seed that is collected in July is usually stored dry until mid-September and then sown. Alternatively, seeds can be stratified at 5°C for 3 months and sown in the spring. Most currants are propagated readily by softwood cuttings or by hardwood cuttings under mist.

*Rosa* All species late September
Rose

Commercial roses for the prairies are rarely propagated by seed; for breeding purposes rose seeds can be germinated after stratification at 21°C for 2 months, followed by stratification at 5°C for 3 months.

Many hardy roses, including all those of the Parkland series ('Assiniboine,' 'Cuthbert Grant,' 'Morden Amorette,' 'Morden Ruby,' 'Adelaide Hoodless,' 'Morden Cardinette,' and 'Morden Centennial'), are best propagated by leaf-bud cuttings.

Cultivars of *R. spinosissima* L. (Scotch rose, Burnet rose), such as 'Harison's Yellow,' 'Prairie Dawn,' and 'Hazeldean,' that are difficult to root can be propagated by stolon (underground stem) cuttings but not from true roots. Stolons can be dug from stock plants or pruned from marketable plants in the fall. They should be stored in moist peat moss at 5°C until dormancy is overcome in mid-February. Cuttings that are 7 cm long will sprout and grow actively when potted in the greenhouse. They can be transplanted outdoors in early May and dug as marketable plants in October.

Most improved tender roses have been budded on seedling or clonal rootstocks using *R. multiflora* Thunb. ex J. Murr (Japanese rose), which is not hardy enough for the prairie region. These plants are often difficult to grow on the prairies, either because their rootstocks are not hardy or because they produce suckers following even limited winter kill of the propagated cultivar. *R. canina* L. (dog rose) seedlings are recommended as rootstock for the Scotch rose cultivars, which are difficult to root.

*Salix* All species early June
Willow

Willows are propagated from seed only for research. The seed requirements for extraction, storage, and germination are similar to those of poplars.

Willows produced commercially on the prairies can be propagated readily from hardwood cuttings planted as unrooted cuttings directly into the field. An exception is *S. exigua* (coyote willow), which should not be propagated in this way because it suckers excessively. Instead, it should be budded in late August to *S. alba* 'Vitellina' (yellowstem willow) or grafted in early spring to hardwood cuttings that are subsequently lined out in the field.

| | | |
|---|---|---|
| *Sambucus*<br>Elder | *S. racemosa* L.<br>(European red elder) | late July |

Seed should be sown in early October to germinate well in the first spring. Alternatively, stratify the seed at 5°C for 3 months and sow in the spring.

Softwood cuttings of the improved cultivar, 'Sutherland Golden,' are rooted readily. The dwarf cut-leaf cultivar, 'Goldenlocks,' is also propagated from softwood cuttings, although it roots with more difficulty and grows more slowly than 'Sutherland Golden.'

| | | |
|---|---|---|
| *Shepherdia*<br>Buffaloberry | *S. argentea* (Pursh) Nutt.<br>(silver buffaloberry) | late September |
| | *S. canadensis* (L.) Nutt.<br>(russet buffaloberry) | late July |

Buffaloberry seed should be cleaned, stored in polyethylene bags at 5°C, and sown in mid-September. The seed germinates well in the first spring.

| | | |
|---|---|---|
| *Sorbaria* | *S. sorbifolia* (L.) A. Braun<br>(Ural false spirea) | late August |

Ural false spirea seed should be sown in the fall or stratified during the winter at 5°C for 1 or 2 months and sown in the spring.

Plants can also be grown from divisions. The improved cultivar, 'Aurora', from the interspecific cross of *S. arborea* × *S. sorbifolia*, is routinely propagated by divisons and sucker growth.

| | | |
|---|---|---|
| *Sorbus*<br>Mountain ash | *S. americana* Marsh.<br>(American mountain ash) | early September |
| | *S. aucuparia* L.<br>(European mountain ash) | early September |
| | *S. decora* (Sarg.)<br>C. K. Schneid.<br>(showy mountain ash) | early September |
| | *S. scopulina* Greene<br>(Greene's mountain ash) | early September |

Fruit should be picked as soon as it is ripe (noticeable coloration) to avoid losses to birds. Seed that is cleaned, surface dried, and stored in polyethylene bags at 5°C will retain its viability for several years. The recommended propagation procedure is to sow in the fall. Alternatively, mountain ash seed may be stratified at 5°C for 3–4 months and sown in the spring. Cultivars from a range of European, Asiatic, and American species have been successfully budded on showy mountain ash and Greene's mountain ash, indicating a wide range of compatibility.

*Spiraea*
Spirea

Spirea cultivars and selections propagate readily from softwood cuttings under mist.

| | | |
|---|---|---|
| *Syringa*<br>Lilac | *S.* ×*hyacinthiflora* (Hort. Lemoine) Rehd.<br>(early lilac) | mid-September |
| | *S. meyeri* C. K. Schneid. 'Palibin'<br>(Palibin littleleaf lilac) | late September |
| | *S. reticulata* (Blume) Hara<br>(Japanese tree lilac) | early October |
| | *S. villosa* Vahl<br>(late lilac) | late September |
| | *S. vulgaris* L.<br>(common lilac) | mid-October |

Sowing lilac seed in September usually results in good germination in the spring with all species except the Japanese tree lilac. It may be necessary to protect against late spring frosts because germination occurs early. It is important to keep the seedbed well moistened before germination. Fall-sown seed of Japanese tree lilac germinates in midsummer; seed stratification at 5°C for 2 months and at 21°C for 2½ months, followed by spring sowing, produces prompt germination.

Littleleaf lilac and late lilac root well, whereas the early lilac roots less readily from softwood cuttings. Rooting is most successful if you take cuttings early in the growing season, while the stems are still highly succulent.

Cultivars of lilac can be grafted onto a root piece of green ash. The grafted lilac should be planted deeply into the soil so that it will eventually grow on its own roots. Lilacs will bud successfully on *S. villosa* lilac rootstock; however, sucker growth from the rootstock is troublesome.

*Tamarix*
Tamarisk

*T. ramosissima* Ledeb. 'Rubra' (five-stamen tamarisk, Amur tamarisk) is propagated by softwood or hardwood cuttings under mist.

| | | |
|---|---|---|
| *Taxus*<br>Yew | *T. canadensis* Marsh.<br>(Canada yew) | August |

Seed can be sown as soon as it is collected or it may be stored, stratified at 21°C for 3 months and at 5°C for an additional 4 months, and sown in the spring. Seed propagation is not usually used because of seedling variability, seed dormancy, and slow seedling growth.

Softwood cuttings are the preferred method of propagation.

| | | |
|---|---|---|
| *Thuja*<br>Arborvitae | *T. occidentalis* L.<br>(eastern white cedar, arborvitae) | August |

Germination of native arborvitae seed can be expected in the spring, following fall sowing. Sow the seed in the shade, and water lightly and frequently to aid seedling establishment.

Improved cultivars of arborvitae are propagated during the winter or sometimes during the summer by evergreen cuttings rooted under light mist or occasional sprinkling.

| | | |
|---|---|---|
| *Tilia*<br>Basswood | *T. americana* L.<br>(American linden, American basswood) | mid-September |
| | *T. cordata* Mill.<br>(littleleaf linden) | late September |
| | *T. flavescens* A. Br.<br>(Dropmore linden) | late September |

American linden has been traditionally regarded as a difficult species to germinate. Studies at Morden indicate that 50% germination can be expected from seed that is collected at the appropriate time and sown immediately. Seed should be collected just when the hull turns from green to grayish brown. If the seed is not collected at this stage of maturity, the following method of handling has proved to be reliable at Morden:

- remove the hard, dry hull by mechanical means;
- soften the seed coat by treating it with concentrated sulfuric acid for 45 minutes;
- stratify the seed at 5°C for 4–5 months;
- sow the seed outdoors in May.

Dropmore linden does not come true from seed, although its seedlings are satisfactory understocks. Dropmore linden and littleleaf linden seed should be collected at the mature green stage and sown in the fall or stratified for 3 months at 5°C and sown in the spring.

Budding studies at Morden have demonstrated a wide degree of compatibility among linden species. Littleleaf linden seedlings have proved to be highly reliable for rootstock, and limited trials with American linden and Dropmore linden rootstocks have also been successful. Growth rates were similar for all rootstocks.

| | | |
|---|---|---|
| *Ulmus*<br>Elm | *U. americana* L.<br>(American elm) | early to mid-June |
| | *U. davidiana* Planch. var. *japonica*<br>(Rehd.) Nakai<br>(Japanese elm) | early to mid-June |
| | *U. pumila* L.<br>(Siberian elm) | early to mid-June |

Seeds of American and Siberian elm germinate promptly if they are sown after they are collected. Some sources of Japanese elm require stratification at 5°C for 2 weeks to ensure good germination. The best results are achieved when the seed is stratified soon after it is collected, and then sown. Elm seed can be stored successfully in a sealed container at 5°C for a year.

Selections of American elm, including the cultivar 'Exhibition Boulevard,' have been successfully budded or grafted to seedling rootstock of the species. Selections of Japanese elm were incompatible on rootstock of American elm but were compatible on Siberian elm in studies at Morden. Grafting or spring budding on rootstock of Siberian elm or Japanese elm resulted in higher plant stands than summer budding, which was improved by delaying budding until late August or early September.

| | | |
|---|---|---|
| *Viburnum* | *V. lantana* L. (wayfaring tree) | early September |
| | *V. lentago* L. (nannyberry) | late September |
| | *V. rafinesquianum* Schult. (downy arrowwood) | mid-September |
| | *V. trilobum* Marsh. (high bush-cranberry) | mid-September |

Viburnum seed usually requires more than a year to germinate. It possesses both root and epicotyl dormancy. The former is overcome by warm, moist conditions and the latter by cool, moist conditions. With the exception of the wayfaring tree, the seed should be stored over the winter and sown in July. Germination occurs the following spring. The seed of the wayfaring tree should be collected just before the fruit is fully ripe, cleaned, and sown immediately. It should germinate during the first spring.

*Viburnum opulus* L. 'Nanum' (dwarf European cranberry bush) and *V. trilobum* 'Compactum' (dwarf high bush-cranberry) are propagated by softwood cuttings.

| | | |
|---|---|---|
| *Vitis* Grape | *V. riparia* Michx. (riverbank grape) | early October |

Grape seed should be sown in the fall, soon after it is collected, or stratified for 3 months at 5°C and sown in the spring. Cultivars of grape may be propagated from softwood cuttings under mist.

*Weigela*

Cultivars of weigela are propagated readily from softwood or hardwood cuttings under mist.

## Specific propagation methods for herbaceous perennials

| Name | Method of propagation* | | | Comments |
|---|---|---|---|---|
| | Seed | Divisions | Cuttings | |
| *Achillea millefolium* L. (yarrow) | 2 | 1 | | Divisions in spring |
| *Achillea ptarmica* L. (sneezewort, sneezeweed) | 2 | 1 | | Divisions in spring |
| *Aconitum* spp. (monkshood) | 1 | 2 | | Divisions in fall; sow seed in mid-summer |
| *Adonis vernalis* L. (pheasant's-eye) | 2 | 1 | | |
| *Aegopodium podagraria* L. (goutweed) | | 1 | | |
| *Ajuga* spp. (bugleweed) | | 1 | | Divisions in spring |
| *Allium* spp. (onion) | 1 | 2 | | A few species do not seed |
| *Althaea rosea* (L.) Cav. (hollyhock) | 1 | | | Sow in the fall for spring germination |
| *Anemone sylvestris* L. (snowdrop anemone) | 1 | 1 | | |
| *Anthemis tinctoria* L. (golden-marguerite) | 1 | | | |
| *Aquilegia* hybrids (columbine) | 1 | | | |
| *Artemisia* spp. (wormwood) | | 1 | | Divisions in spring |
| *Aster amellus* L. (Italian aster) | | 1 | | See section following for details |
| *Aster* hybrids | | 1 | | See section following for details |
| *Bergenia cordifolia* (Haw.) Sternb. (heart-leaf bergenia) | | 1 | | Divisions in spring |

*Numbers indicate the order of the preferred method of propagation: 1 is recommended and 2 and 3 are alternatives.

## Specific propagation methods for herbaceous perennials
(continued)

| Name | Method of propagation* | | | Comments |
|---|---|---|---|---|
| | Seed | Divisions | Cuttings | |
| *Campanula carpatica* Jacq. (tussock bellflower) | 1 | 2 | | |
| *Cerastium tomentosum* L. (snow-in-summer) | 1 | 2 | | |
| *Chrysanthemum coccineum* Willd. (pyrethrum) | 1 | | | |
| *Chrysanthemum* hybrids | | 1 | | See section following for details |
| *Chrysanthemum maximum* Remond (max chrysanthemum, daisy chrysanthemum) | 2 | | | |
| *Chrysanthemum serotinum* L. (giant daisy) | | 1 | | |
| *Clematis integrifolia* L. (solitary clematis) | 1 | 2 | | |
| *Clematis recta* L. (ground clematis) | 1 | 2 | | |
| *Convallaria majalis* L. (lily-of-the-valley) | | 1 | | |
| *Delphinium* hybrids (perennial larkspur) | 1 | 2 | | Fresh seed only |
| *Dianthus deltoides* L. (maiden pink) | 1 | 2 | | See section following for details |
| *Dianthus plumarius* L. (cottage pink, grass pink) | 1 | 2 | | See section following for details |
| *Dianthus* hybrids (pink) | | 2 | 1 | Short cuttings from base of plant |
| *Dicentra spectabilis* (L.) Lem. (bleeding-heart) | 1 | 2 | | |
| *Dictamnus albus* L. (gas plant) | 1 | | | Dormant seed problem |

*Numbers indicate the order of the preferred method of propagation: 1 is recommended and 2 and 3 are alternatives.

## Specific propagation methods for herbaceous perennials
(continued)

| Name | Method of propagation* | | | Comments |
|---|---|---|---|---|
| | Seed | Divisions | Cuttings | |
| *Echinops ritro* L. (small globe thistle) | 1 | | | |
| *Erigeron* hybrids (fleabane) | | 1 | | Divisions in spring |
| *Eryngium maritimum* L. (sea holly) | 1 | | | |
| *Filipendula hexapetala* Gilib. (dropwort) | | 1 | | |
| *Gaillardia aristata* Pursh (blanketflower) | 1 | 1 | | |
| *Geranium* spp. (crane's-bill) | 1 | 1 | | |
| *Gypsophila paniculata* L. (baby's-breath) | 2 | | 1 | Cuttings in fall |
| *Gypsophila repens* L. (creeping baby's-breath) | 2 | | 1 | Cuttings in fall |
| *Helianthus* spp. (sunflower) | 1 | 2 | | Hybrid types may not seed |
| *Hemerocallis* hybrids (daylily) | | | | |
| *Heuchera* hybrids (coralbells) | 3 | 1 | 2 | See section following for details |
| *Hosta ventricosa* Stearn (blue plantain lily) | | 1 | | |
| *Iberis sempervirens* L. (edging candytuft) | 2 | | 1 | Improved cultivars are cuttings |
| *Iris* ×*germanica* L. hybrids (flag, fleur-de-lis) | | 1 | | See section following for details |
| *Iris pumila* L. hybrids | | 1 | | See section following for details |
| *Iris sibirica* L. hybrids (Siberian iris) | | 1 | | See section following for details |

*Numbers indicate the order of the preferred method of propagation: 1 is recommended and 2 and 3 are alternatives.

## Specific propagation methods for herbaceous perennials
(continued)

| Name | Method of propagation* | | | Comments |
|---|---|---|---|---|
| | Seed | Divisions | Cuttings | |
| *Lathyrus latifolius* L. (everlasting pea, perennial pea) | 1 | | | |
| *Liatris* spp. (blazing-star) | 1 | | | Keep seedlings rather dry |
| *Lilium* spp. and hybrids (lily) | 1 | 2 | | See section following for details |
| *Limonium latifolium* (Sm.) O. Kuntze (sea lavender) | 1 | | | |
| *Lupinus polyphyllus* Lindl. (many-leaved lupine) | 1 | | 1 | See section following for details |
| *Lychnis chalcedonica* L. (Maltese-cross) | 1 | 2 | | |
| *Lychnis viscaria* L. (German catchfly) | 1 | 2 | | |
| *Lythrum virgatum* L. (lythrum,wand loosestrife) | | | 1 | See section following for details |
| *Macleaya cordata* (Willd.) R. Br. (plume poppy) | 1 | 1 | | |
| *Mertensia virginica* (L.) Pers. (Virginia bluebells) | 1 | | | Sow in fall |
| *Molinia caerulea* L. Moench (moore grass) | | 1 | | Divisions in spring |
| *Monarda didyma* L. (monarda, Oswego tea) | 1 | 1 | | |
| *Monarda* hybrids | | 1 | 1 | In spring or early summer |
| *Nepeta* hybrids (catmint) | | 1 | 1 | In spring or early summer |
| *Oenothera missourensis* Sims (evening primrose) | 1 | | | |

*Numbers indicate the order of the preferred method of propagation: 1 is recommended and 2 and 3 are alternatives.

## Specific propagation methods for herbaceous perennials
(continued)

| Name | Method of propagation* | | | Comments |
|---|---|---|---|---|
| | Seed | Divisions | Cuttings | |
| *Paeonia* hybrids (peony) | 1 | | | See section following for details |
| *Papaver nudicaule* L. (Iceland poppy) | 1 | | | Normal germination in early fall |
| *Papaver orientale* L. (Oriental poppy) | 1 | 1 | | |
| *Penstemon glaber* Pursh (blue penstemon) | 3 | 2 | 1 | See section following for details |
| *Phalaris arundinacea* var. *picta* L. (ribbon grass) | | 1 | | |
| *Phlox borealis* Wherry (arctic phlox) | | 1 | | |
| *Phlox paniculata* L. (perennial phlox) | 2 | 1 | 1 | Root divisions or cuttings in spring |
| *Phlox subulata* L. (moss pink) | | 1 | | |
| *Physostegia virginiana* (L.) Benth. (obedient plant) | 2 | 1 | | See section following for details |
| *Platycodon grandiflorus* (Jacq.) A. DC. (balloon flower) | 1 | | | |
| *Polemonium caeruleum* L. (Jacob's-ladder) | 1 | 2 | | |
| *Polygonatum* spp. (Solomon's-seal) | | 1 | | Seedlings grow slowly |
| *Primula* spp. (primrose) | 1 | 2 | | |
| *Ranunculus acris* L. (tall buttercup) | | 1 | | |
| *Rudbeckia laciniata* L. (golden-glow, coneflower) | 1 | | | Double form does not seed |

*Numbers indicate the order of the preferred method of propagation: 1 is recommended and 2 and 3 are alternatives.

## Specific propagation methods for herbaceous perennials
(concluded)

| Name | Method of propagation* | | | Comments |
|---|---|---|---|---|
| | Seed | Divisions | Cuttings | |
| *Salvia pratensis* L. (meadow clary) | 1 | | | |
| *Scilla siberica* Andr. (Siberian squill) | 1 | 1 | | Seeds and divisions are few |
| *Sedum* spp. (stonecrop) | | 1 | 1 | |
| *Sempervivum* spp. (houseleek) | | 1 | | |
| *Thalictrum* spp. (meadow rue) | 1 | 2 | | |
| *Thymus* spp. (thyme) | 2 | 1 | | |
| *Tradescantia bracteata* Small (spiderwort) | 1 | 2 | | |
| *Tulipa* hybrids (tulip) | | 1 | | Improved cultivars from bulbs only |
| *Tulipa tarda* Stapf | 1 | 2 | | Seed in early fall |
| *Veronica* spp. (speedwell) | 1 | 1 | | |
| *Vinca herbacea* Waldst. & Kit. (periwinkle) | | 1 | | |

*Numbers indicate the order of the preferred method of propagation: 1 is recommended and 2 and 3 are alternatives.

*Aster*

See *Chrysanthemum* for similar methods.

*Chrysanthemum*

These plants increase naturally by long or short stolons. They can be easily propagated by separating each growing point with 5–15 cm of stem in early spring. Propagules should be pricked into flats or containers and allowed to root under humid conditions for 1–2 weeks (Fig. 5).

Propagation of *Chrysanthemum*, *Monarda*, *Erigeron* and other plants of this type can be from small succulent stem cuttings. Rooting will take place under mist in 10–15 days. Cuttings must be taken during the short period of vegetative growth in early spring. Propagation from stolons rather than cuttings is recommended, because stolons are easier to handle.

Hardy, early flowering garden chrysanthemums are induced to flower by accumulated heat units, not by day length, as are florist-type chrysanthemums. Plant early in the season, before the hot weather arrives, to increase the amount of vegetative growth, which in turn will produce an abundant display of fall blooms.

FIG. 5 Propagules of chrysanthemum obtained from stolons. Many plants can be started from each stock plant.

*Dianthus*

Many improved carnations are sterile and therefore cannot be grown from seed. These cultivars are propagated from short, leafy shoots found at the base of the plant. Kept under mist, these cuttings should root in 2 or 3 weeks. Any shoots that have begun to elongate contain bud initials and will not root satisfactorily.

*Erigeron*

See *Chrysanthemum* for similar methods.

*Heuchera*

Coralbells are often grown from seed, although growth is slow and seedlings are variable. Hardy cultivars must be propagated vegetatively. Propagation is most effective in mid to late summer. The spreading crown can be divided into many segments, with each segment 3–10 cm or more long. These divisions root readily. For more rapid numerical increase, cut the 4–10 leaves of each division so that a small piece of the stem is attached (Fig. 6). These cuttings root readily under mist but produce salable plants slowly, compared with divisions. The thick basal part of long stems, without leaves, will also grow to produce new plants if it is partly covered with a moist medium.

*Iris*

This genus consists of a large diverse group of plants with various types of specialized underground structures, including corms and rhizomes (underground horizontal stems). The types grown in the Canadian prairies have rhizomes and may be propagated by separating the rhizomes from the large and often tough root system. Divisions consisting of a short piece of rhizome with roots and a fan of leaves can be made in July or August if irrigation water can be provided; otherwise, divisions can be made in late April or early May. Iris species may be grown from seed, which germinates following stratification at 5°C for 3 months.

*Lilium*

Most garden lilies have a hybrid origin; therefore they must be propagated vegetatively. Some cultivars produce bulblets in the axils of the leaves or at the base of the stem. Bulblets can be removed from the stock plant during dormancy and grown independently as a means of propagation. When many plants are required or when few natural bulb-

FIG. 6 Leaf cuttings of coralbell.

lets are produced, lilies can be grown from bulb scales. In late winter or early spring, remove a few scales from the outside of large bulbs or dismember the entire bulb by lifting the scales away from the bulb. Store scales in moist peat moss at 5°C until bulblets form. When bulblets have rooted, the entire scale with its attached bulblet can be planted.

*Lupinus*

Lupines are usually grown from seed. Fall-sown seed germinates outdoors in the first spring. The seed has a waterproof seed coat, which requires mechanical or acid scarification for 30 minutes if you are going to sow seed indoors. Deep, narrow containers are recommended for greenhouse production, because lupines develop a long taproot. Vegetative propagation from offsets may be used for valuable selections, although there is a limited number of offsets that can be obtained from either old flower stalks or from the crown of the plant.

*Lythrum*

Softwood cuttings of lythrum taken in early summer root within 2 weeks under mist. As the season advances, rootability of the cuttings decreases.

*Monarda*

See *Chrysanthemum* for similar methods.

*Paeonia*

Peony cultivars are propagated by division. Old, established plants may have a crown diameter of more than 30 cm that contains many buds and long, thick storage roots. Divisions are best made in September by cutting apart the old root and obtaining pieces, each with some root and two or three buds. Root pieces without buds seldom grow. Divisions produce salable plants in one year, if they are replanted at once in nursery rows.

*Penstemon*

The penstemons are a large group of plants that vary widely, from carpet-forming evergreens to tender subtropicals and from hardy, drought-tolerant species to moisture-loving species. Plants can be grown from seed that requires stratification at 5°C for 1–2 months. The most useful group of penstemons on the prairies are derived from various hybrids of *P. glaber* (e.g. 'Westlander'). Cultivars of this group are easily propagated from the small rosettes that form on the lower stems in late summer. When rosettes are divided from the stock plant, they usually have roots or root initials. Because they are very drought tolerant, their only requirement for establishment is moist soil.

*Physostegia*

See *Chrysanthemum* for similar methods.

*Solidago*

See *Chrysanthemum* for similar methods.

## Glossary

**aril** An exterior covering or an appendage of some seeds.
**axillary bud** A bud located at the point where the leaf joins the stem.

**basal** At the lower end of a stem or other plant part.
**budding** The process of inserting a bud from a plant into an opening in the bark of another kind of plant to propagate a cultivar.
**budwood** A piece of stem containing buds of a cultivar that are used in the budding operation.

**cambium** The thin formative layer of living cells beneath the bark from which growth occurs.
**chip budding** A type of budding in which a chip of bark is removed from near the base of the rootstock and is replaced by another chip of the same size and shape from budwood containing a bud of the desired cultivar.
**compatibility** The capability of different plants to unite vegetatively and to grow together following grafting or budding.
**corm** A rounded, thick, modified underground stem that bears membranous or scaly leaves and buds and that acts as a vegetative reproductive structure; comparable to a bulb.
**cultivar** A cultivated variety; any group of plants distinct in certain characteristics, maintained by appropriate propagation methods.
**cutting** Any vegetative plant part removed from a plant specifically for the purpose of producing additional plants of the same type.

**deciduous** Having leaves that fall off in autumn; not evergreen.
**dehiscent** Naturally splitting open at maturity for seed dispersal.

**embryo** The living portion of a seed, which upon germination elongates and differentiates to form a new plant.
**endocarp** The exterior of the seed, which serves as a protective covering.
**etiolated** Lacking natural chlorophyll because of growth in reduced sunlight or in the dark; pale-colored.

**fumigation** The application of a vapor to destroy weed seeds or pests.
**fungicide** A chemical used to control fungal diseases.

**genus** A category of botanical classification ranking between the family and the species and comprising structurally related species.
**grafting** The process of fitting a scion and a rootstock together so that the cambium layers can unite and the scion can grow as the desired cultivar.

**herbaceous** Leafy; of nonwoody plant tissue that dies at the end of each growing season.
**hull** The hard covering that surrounds some seeds, for example, American linden.

**indehiscent** Not naturally splitting open at maturity.

**layering** A means of asexually propagating plants by placing a stem in the ground so that roots will form along the stem.

**offset** A segment of the crown of a plant which when removed from the plant is capable of producing another plant.

**perennial** A plant that lives for more than 2 years.
**propagation** The process of increasing the number of plants either by seed or by vegetative methods.
**propagule** A plant part used in propagation.
**proximal** Nearest to the point of attachment.

**rhizome** An underground rootlike stem; it usually grows horizontally, is often thickened by deposits of reserve food material, produces shoots above and roots below, and is distinguished from a true root because it possesses buds, nodes, or scalelike leaves.
**rootstock** A plant part on which a bud or scion is budded or grafted and that forms the root system.
**rosette** A cluster of leaves on a very short stem or axis arising basally from a crown.

**scarification** The process of etching the seed coat of hard seeds to facilitate water intake and gas exchange so that the seed can germinate; usually accomplished mechanically or with acid.
**scion** A short length of stem containing two or three buds and used in grafting to form the upper part of the graft union.
**stolon** A horizontal stem that grows either above or below ground level and is distinguished from a rhizome in that it is not thickened with food reserves.
**stratification** A pregermination treatment used for overcoming dormancy in certain seeds; the treatment consists of placing seeds in a moist, well-aerated medium for a specified number of months, usually at 3–5°C but occasionally at 20–22°C.
**strobile** A membranous, imbricated bract that surrounds certain seeds, for example, hop hornbeam.
**succulent** Soft, juicy, fleshy; of immature plant growth, as in new growth of trees or in perennials.

**taproot** A primary root that grows downward and that must be pruned before significant lateral branching can occur.
**testa** The outer seed coat.
**T-budding** A type of budding in which the bark of the rootstock is slit by horizontal and vertical cuts in the shape of a T, behind which a bud of the desired cultivar is placed.

**vegetative** Related to the growth functions rather than to the reproductive functions; of leaves, stems, and roots.

**whip** A plant that has one season's growth from the time of budding or grafting.

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## Index of common names